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Structures
for Starting and Growing
Ornamental Plants

Kenneth Post

STRUCTURES FOR STARTING AND GROWING ORNAMENTAL PLANTS

KENNETH POST

THE purpose of this bulletin is to give enough detail to enable one to build the various types of structures in which plants are grown. The types vary, depending on their use.

The 1945 census estimated that the sale of horticultural specialities in New York State amounted to $35,000,000. Most of this probably is from greenhouse-grown material. Lath houses, cloth houses, and other structures contributed to the total production. Plants that require shade in summer and protection in winter may be grown in lath houses. They are of special value to the nurseryman.

Most cut flowers planted in gardens and in the open are started in frames. Frames also are valuable to the florist for forcing bulbs, storing stock, hardening plants for out-of-doors, and for other purposes.

The number of cloth houses has increased since 1930. The greater stem length, flower size, and cleanliness of foliage of many annuals grown for market is attributed to their culture under such structures.

KINDS OF WOOD

CYPRESS, redwood, chestnut, or cedar are the most desirable woods for these structures. The wood is exposed to conditions most favorable to decay and must, therefore, be decay-resisting to endure. Less resistant woods may be treated to prevent decay. Materials containing copper or zinc are satisfactory, but creosote in any form must *not* be used because of the toxic fumes that come from it.

STRUCTURES

Wardian Case

THE Wardian case is used to prevent rapid loss of water from seedlings, grafted plants, and cuttings. It is essentially an air-tight chamber, and may be used in the greenhouse or the home.

The standard Wardian case consists of a frame of wood with a glass top. The top is constructed like the sash on a coldframe but usually is hinged at the top (figure 1). It may be heated from below with steam or electricity.

AUTHOR'S ACKNOWLEDGMENT. Photographs for the cover and for figures 11, 12, 15, and 16 are from Lord and Burnham Company, that for figure 7 from the General Electric Company, and that for figure 17 from the Pittsburgh Cut Flower Company.

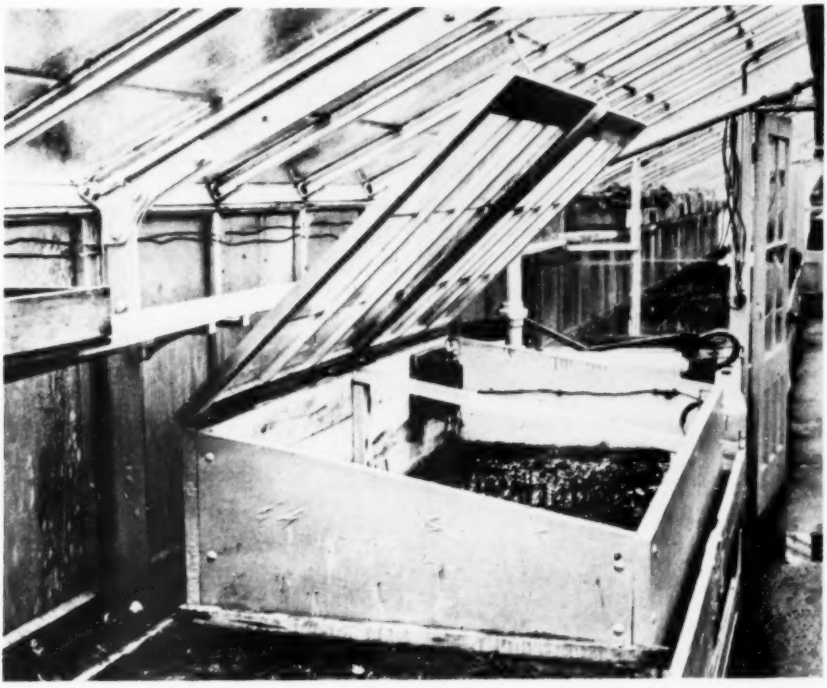

FIGURE 1. A WARDIAN CASE

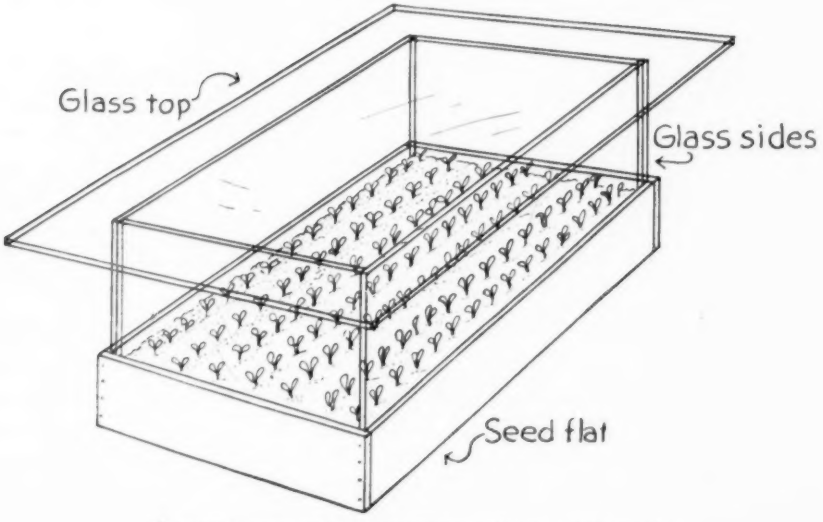

FIGURE 2. HOW TO KEEP HUMIDITY HIGH IN A SEED FLAT

FIGURE 3. A GLASS COVER OVER A FLOWER POT FOR SEED GERMINATION

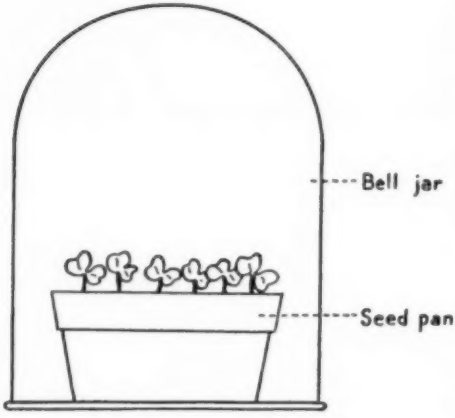

FIGURE 4. A SIMPLE WARDIAN CASE

In the home it may be used to grow plants that require a humid atmosphere. Used in this manner it is often called a *terrarium*. The simplest type for use in the home consists of a standard greenhouse flat or pot with a piece of glass cut to fit over it (figure 2 and 3). A fish bowl with a glass top or a bell jar (figure 4) placed over a pot of soil are simple Wardian cases.

Coldframes

The coldframe utilizes the sun's heat. The soil is heated during the day and gives off its heat at night to keep the plants warm. No artificial heat of any kind is applied. The frame may be banked with straw or strawy manure to insulate it from the outside air and to retain heat. Insulating mats placed over the sash at night also are beneficial during spring to conserve the heat of the sun, and thus to enable one to start plants earlier in the spring. Such mats may be made of straw, bamboo paper, or cloth.

The standard coldframe sash is 3 feet wide by 6 feet long, with three rows of 10-inch glass lapped to allow the water to run lengthwise. The frame (figure 5) is 5 feet 11 inches wide outside and can be built to any length in multiples of 3 feet; that is 6, 9, 12, and so forth. The frame may be set on the ground, or the base may be partly buried with soil to prevent air from entering below the boards.

Coldframes are used to harden plants, which were started in hotbeds or

in the greenhouse, before transplanting them to the field in spring. They are used also for azaleas, heather, hydrangeas, Christmas cherries, bulbs, and perennials before they are brought into the greenhouse to finish growth for sale. Bulbs and perennials may be grown in coldframes early in the season for forcing into flower a few weeks before normal. These are grown directly in the ground, and the sash is placed over them in early spring. Chrysanthemum stock plants and biennials to be planted into the garden in spring are sometimes placed in coldframes for winter protection, and cyclamen, azaleas, and other plants are grown in frames during summer.

Materials

Materials needed for the construction of a two-sash coldframe are the following. Wood 1 inch thick may be substituted throughout, but is less rigid than the 2-inch wood.

1 piece of 2″ × 8″ × 6′
1 piece of 2″ × 14″ × 6′
1 piece of 2″ × 2″ × 6′
2 pieces of 2″ × 6″ × 5′11″
2 pieces of 1″ × 3″ × 5′ 11″
2 pieces of 2″ × (8″ tapered to 2″) × 5′ 11″
(This may be made from one 2″ x 10″ x 5′ 11″)
2 L-irons 2″ × 2″ × 6″
2 L-irons 2″ × 2″ × 12″
24 round-headed bolts 3/8″ × 3″ with washers
30 No. 8 nails

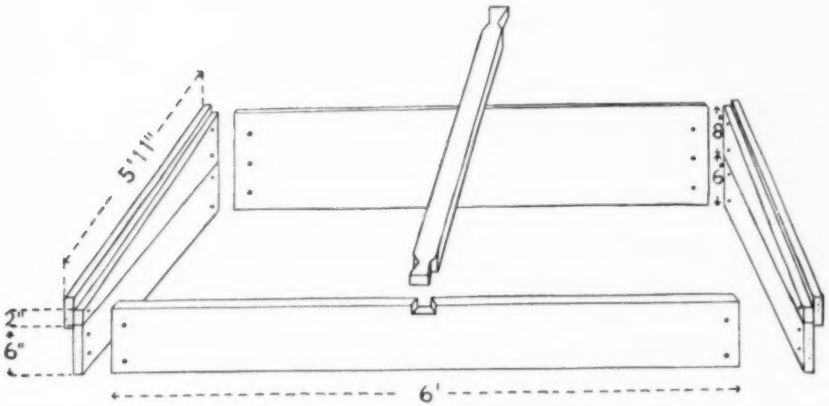

FIGURE 5. CONSTRUCTION DETAILS OF A COLDFRAME

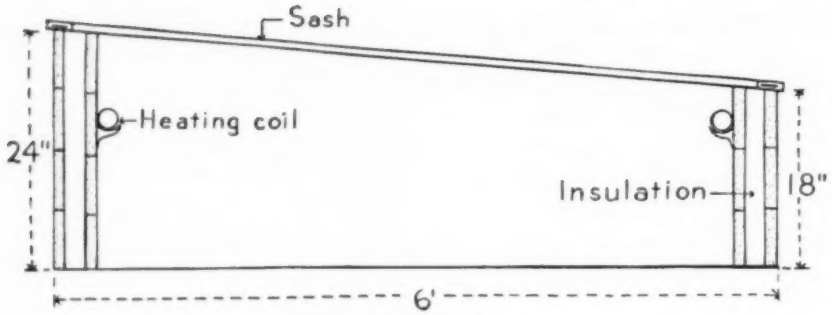

FIGURE 6. A HEATED FRAME

Heated Frames

The construction of heated frames is the same as that for coldframes except that in heated frames the walls are sometimes insulated (figure 6). Heated frames are also somewhat higher from the ground to permit tall-growing plants to be placed in them. Artificial heat is supplied from above the soil by the use of steam, hot water, or electricity (figure 7).

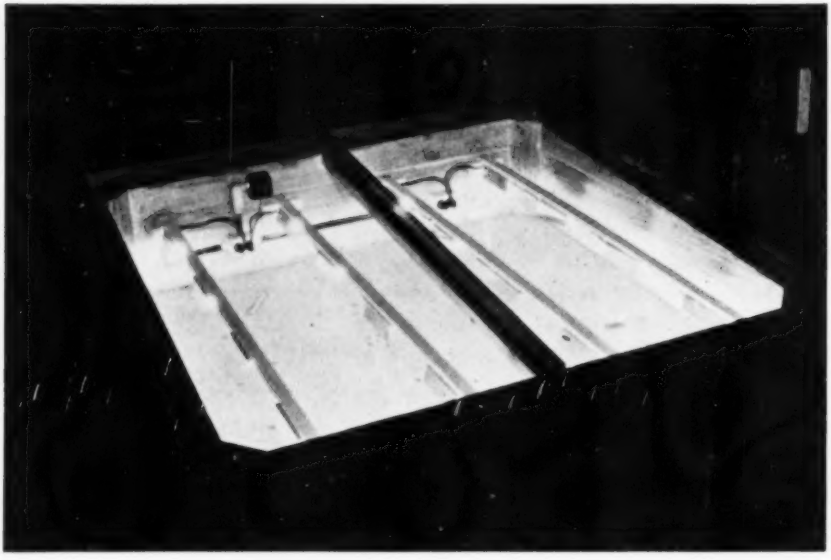

FIGURE 7. A COLDFRAME HEATED AND LIGHTED WITH LIGHTS
The lights are operated by a thermostat

Heated frames are preferred for bulbs, azaleas, hydrangeas, chrysanthemum stock, and for carrying bedding plants in early spring where greenhouse space is not available.

Solar Frames

The solar frame depends upon the sun to supply heat to the media in which cuttings are placed for rooting. The sun shines through the sash near the ground and heats bricks or stones (figure 8) which remain warm during the night and supply heat to the media above.

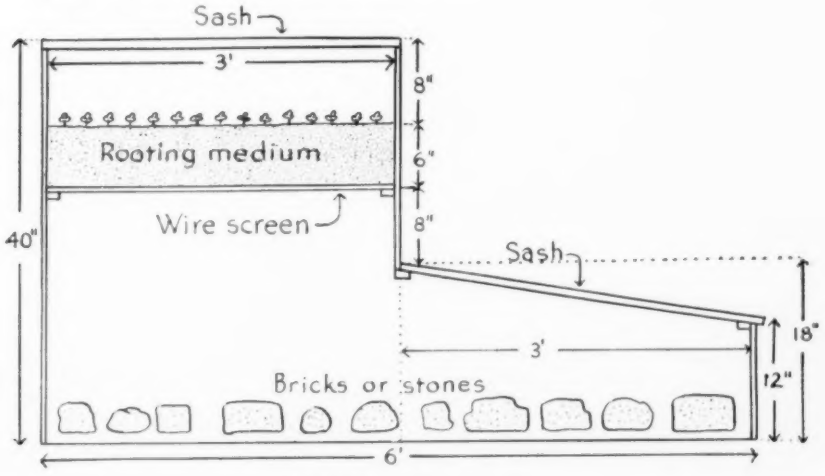

FIGURE 8. A SOLAR FRAME

The lower sash may be removed on hot days to prevent excessive heat accumulation. The upper sash usually is shaded from the sun. The box in which the rooting media is placed has a screen bottom which permits good drainage and aeration.

The solar frame is used largely for summer propagation where it is desirable to have bottom heat. It has been found especially valuable for blueberry propagation.[1] Doubtless it has considerable use for summer propagation of woody and herbaceous materials.

Hotbeds

Hotbeds are similar to coldframes except that they have some means of artifically heating the soil. This heat may be supplied by decaying horse manure or by electricity. The beds are used largely for starting seeds before

[1]The Propagation of the Highblush Blueberry. By Stanley Johnston. Michigan Agr. Exp. Sta. Special bul. 202:1-22. 1930.

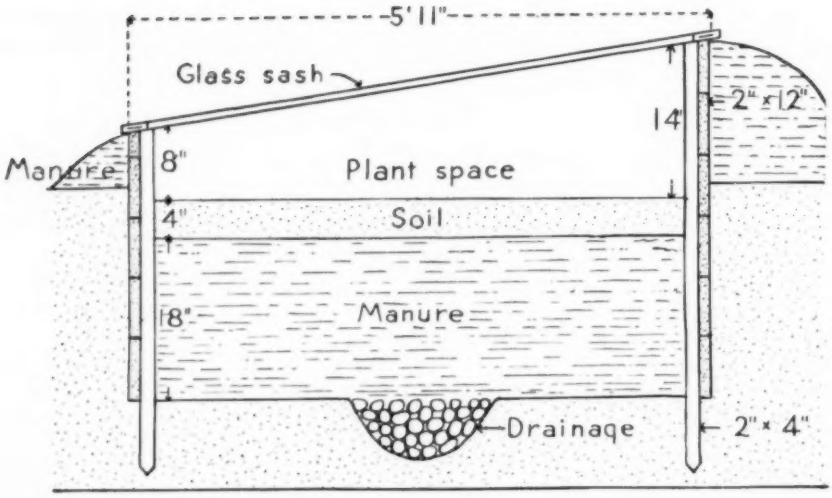

FIGURE 9. A MANURE HOTBED

they could be planted in coldframes and for summer propagation of woody plants by cuttings.

The soil temperature remains higher than in a heated frame which under many conditions is desirable for propagation. The original cost for a manure hotbed is less than the equipment for an electrical hotbed. The electric bed,

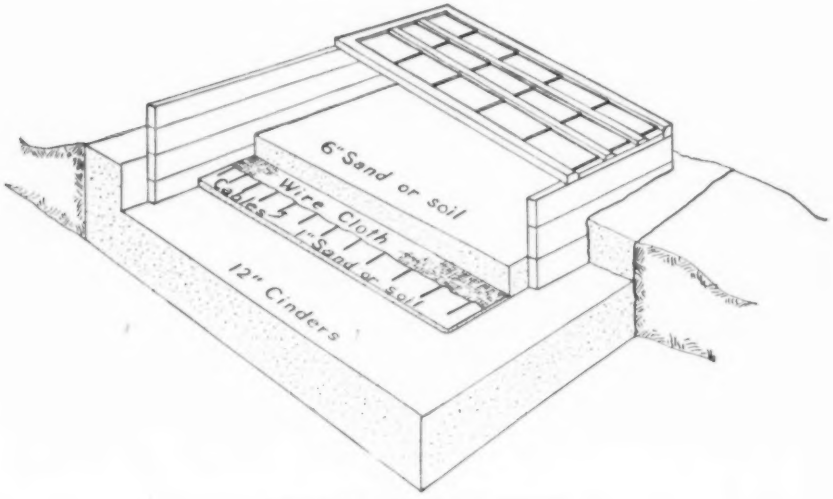

FIGURE 10. AN ELECTRIC HOTBED

however, is more permanent and supplies a more uniform heat than does the manure bed.

The construction of two hotbeds is shown in figures 9 and 10.[2]

Sash Houses and Greenhouses

Sash Houses

The sash house is a cheap greenhouse usable for year-around culture of plants. It is excellent for starting plants and for growing potted plants and some cut flowers. Many florists prefer it for summer growing of potted plants.

The structure may be heated by the dwelling-house furnace if a steam or hot-water system is employed. A coal- or oil-burning water heater may be placed in one end of the sash house and pipes extend from it through the house, or it may be placed in an adjoining head house. The heating pipes may be arranged below or above the bench, depending on the arrangement

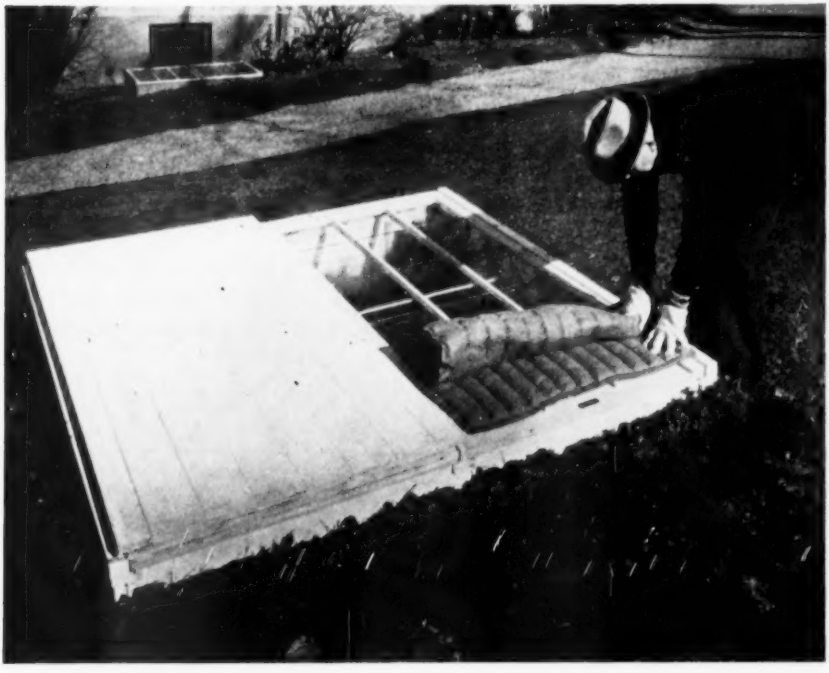

FIGURE 11. COVERING TO HOLD HEAT AT NIGHT

[2]Electric Hotbeds for Propagating Woody Cuttings. By Donald Wyman and Maurice W. Nixon. Cornell Univ. Agr. Exp. Sta. Bul. 618:1–21. 1934.

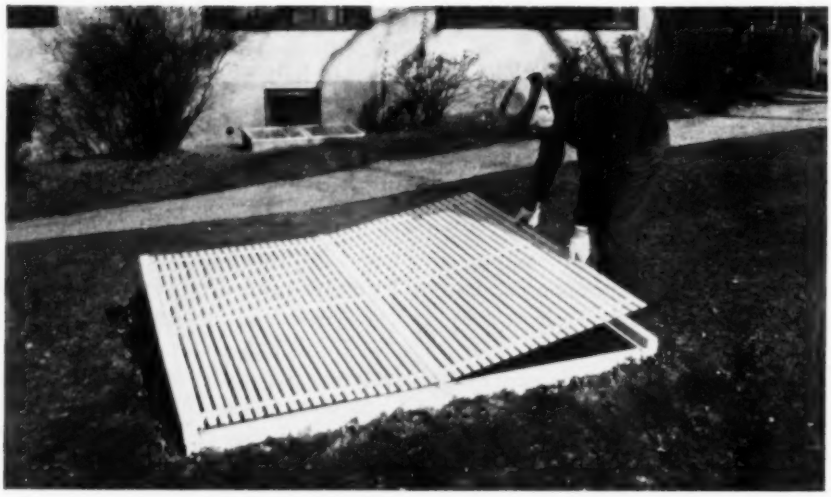

FIGURE 12. LATH SHADE TO PROTECT SEEDLINGS AND SHADE-LOVING PLANTS

of the house or on the plants to be grown. If a stove of any kind is placed in the house, a flue must be used to remove the gases because these are toxic to the plants.

The simplest form of sash house is similar to two cold-frames placed back to back with a path excavated through the center and parallel to the ridge. The heating pipes are placed along the side walls.

A house built entirely above ground, similar to the one excavated for the walk except that glass is used for the side wall, is more satisfactory where the ground is poorly drained. The heating pipes may run under the benches.

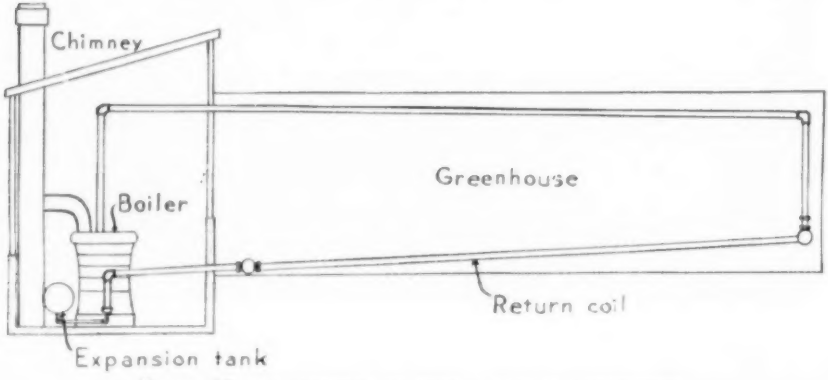

FIGURE 13. ARRANGEMENT OF PIPES IN A SMALL GREENHOUSE

Further information on sash houses is given in Circular 124, *Sash Houses*, of the United States Department of Agriculture.

Materials

Materials needed for the construction of a 12-foot sash house entirely above ground and with one end butted against a work room are the following:

1½ cubic yards of mixed cement for foundation
8 standard coldframe sash
4 storm sash 2½′ × 6′
2 storm sash 2½′ × 5′
6 pieces of glass 18″ × 24″, for 1 gable end
6 pieces of 2″ × 4″ × 12′ for ridge, eave, and sill
10 pieces of 2″ × 4″ × 6′ for rafters
12 pieces of 2″ × 4″ × 5′ for posts
10 feet of ⅞″ × 1⅛″ grooved on one narrow side ¼″
1 piece 2″ × 4″ × 10′ for end cross piece
1 piece 2″ × 4″ × 3′ 6″
70 board feet of matched siding for curtain wall
16 hinges for coldframe sash
24′ galvanized metal 6″ wide for drip
2 pounds of putty
4 pieces of strap iron ⅜″ × 1″ × 18″ drilled or sawtoothed and arranged to lift sash at ridge for ventilation on one side only, or every other sash on either side.

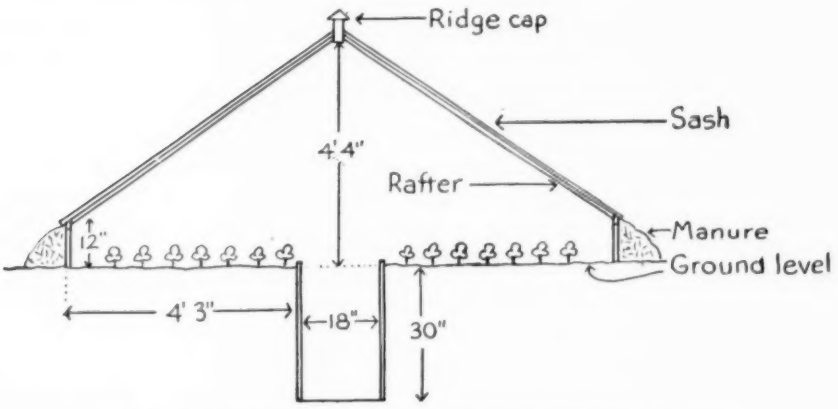

FIGURE 14. A CHEAPLY CONSTRUCTED SASH HOUSE FOR SPRING PLANTING

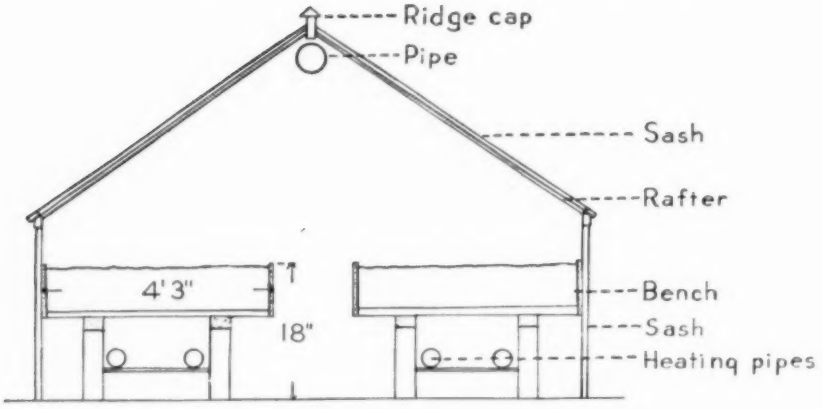

FIGURE 15. SASH HOUSE FOR YEAR-AROUND GROWING

Greenhouses

If one is going to build a glass structure larger than a sash house, it is best to contact some greenhouse-construction company.[3] They are equipped to furnish plans and materials for the most satisfactory structure, and will also outline the best arrangement of benches and walks.

The types of greenhouses are: (1) lean-to, in which one side rests against a building and the roof slopes in one direction (figure 16); (2) ridge and furrow, characterized by several houses connected at the eaves and supported by posts at this point; (3) contiguous, the same as ridge and furrow except for partitions between the houses; (4) separate, in which each house is separated from the other so that no shadow from one falls on another. The separate house is the one most commonly constructed at present for commercial cutflower and potted-plant production.

The separate house is more expensive to build than are other types, but it permits the maximum light to enter and growing conditions can be maintained to meet the requirements of the particular plant grown in the house.

Further and more detailed information may be obtained from Farmers' Bulletin 1318, *Greenhouse Construction and Heating*, published by the United States Department of Agriculture.

[3]A list of greenhouse-construction companies may be obtained by writing to the Department of Floriculture and Ornamental Horticulture, New York State College of Agriculture, Ithaca, New York.

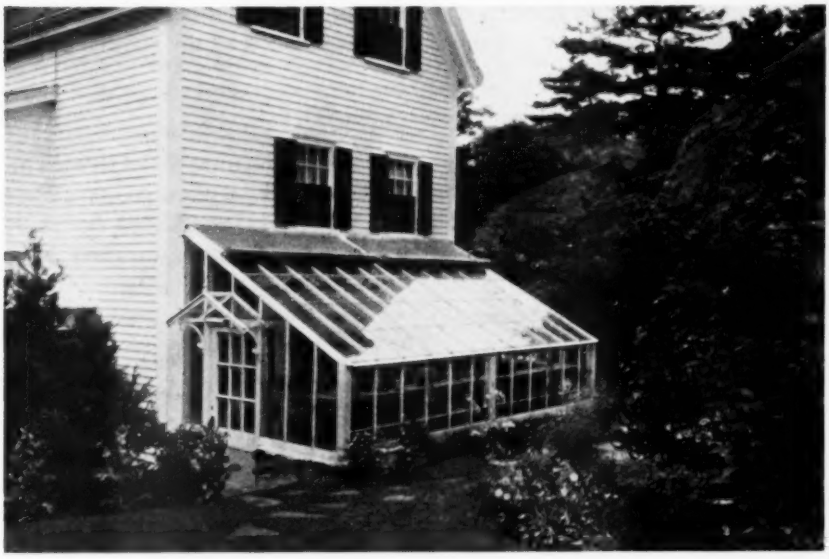

FIGURE 16. A LEAN-TO GREENHOUSE

Piping

Hot water is the most common type of heat used in sash houses or in small greenhouses. A gravity system requires an expansion tank to allow for the increase in volume when the water is heated. The highest point in the heating system should be above the boiler. The hot water rises and flows to the far end of the house through a large flow pipe. It is then re-distributed to smaller pipes (coils) and returned to the lower part of the boiler. The boiler is placed below the pipes in the greenhouse. (Figure 15.)

The amount of piping needed to supply heat to a greenhouse depends upon the temperature to be maintained inside the house compared with that outside the house. If the lowest expected outside temperature is zero and the inside temperature is to be maintained at 50° F., by a hot-water gravity system, 696 feet of 1¼-inch pipe, 607 feet of 1½-inch pipe, or 486 feet of 2-inch pipe are needed for each 1000 square feet of glass or glass equivalent. If a minimum of 60° F. is desired, 920, 801, or 641 feet of 1¼-, 1½-, or 2-inch pipe respectively is necessary for each 1000 square feet of glass or glass equivalent. (Glass equivalent is one-quarter the area of wood or cement.) For each degree below zero expected outside, 1 per cent more piping is

needed. Steam heating takes $^{3}/_{5}$ of the piping here stated. The flow pipe for small houses should be from one to four sizes larger than the returns (coils).

Glass Substitutes

Many cellulose-acetate products are available as glass substitutes. The advantage claimed for them is their ability to transmit ultra-violet light. This is no advantage because ultra violet is not essential for plant growth. They may be somewhat cheaper than glass and should be considered especially from this point of view. Enough time has not been given to test their durability for general use.

Those substitutes built on wire cloth or muslin coated with water-proofing materials reduce the light intensity. The plants may become more spindling than when grown under glass.

Glazing

Coldframe glass usually is fastened in with brads and is not puttied. The sash should be painted before glazing. Greenhouse glass is set in putty which makes an air-tight, water-tight joint.

FIGURE 17. A SMALL GREENHOUSE

Cloth Houses

The cloth house was developed originally to protect plants from leaf hoppers. Nearly all plants grown for summer cut flowers are benefited by the cloth protection because of the slight reduction of light which lowers the rate of water loss from the plants and from the soil. The moisture content of the

FIGURE 18. A CLOTH HOUSE

soil remains higher near the surface. The plants develop larger flowers and longer stems than when grown with no protection; they are injured less by wind and rain; the soil does not splash upon the foliage during rains; the larger insects cannot enter, and those that do enter are more easily controlled.

The most profitable plants grown under cloth are pompom chrysanthemums, given artificial short days to make them flower earlier;[4] China asters, snapdragons, and sweet peas. Retail growers have found that such plants as calendula, zinnia, dahlia, rose, and others also are more valuable when grown by this method. Some growers are using cloth houses for azaleas, kalanchoes, hydrangeas, and a few other miscellaneous potted plants.

Cut flowers must be tied the same as greenhouse-grown material, with

[4]Production of Early Blooms of Chrysanthemums by the Use of Black Cloth to Reduce the Length of Day. By Kenneth Post. Cornell Univ. Agr. Exp. Sta. Bul. 594:1-30. 1934.

wire and cross strings or by some other means. Planting in beds about 4 feet wide is desirable for tying and working.

Construction

Cloth houses should be built to conform with the standard cloth widths, which are 33 feet 4 inches for the top and 6 feet for the sides.[5] The length can be made as great as desired. The house should be in multiples of 33 feet in width and 6 feet high, plus the width of the baseboard used.

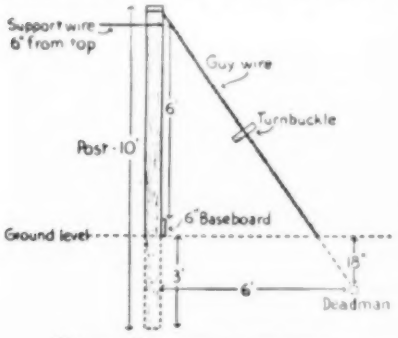

FIGURE 19. POST AND SUPPORT

The posts should be 10 or more feet long and not less than 4 inches in diameter if of wood. They are set from 2½ to 3 feet in the ground, 16½ feet on the center or at closer intervals across the 33-foot width. For a structure in a windy position, the posts are best set 11 feet apart. This gives more support, prevents the cloth from sagging, and is especially desirable for chrysanthemums. Posts are not set where the wires cross in the middle of the 33-foot plot. Some growers clamp the wires together where they cross.

Each post around the outside of the house is anchored to a piece of wood called a *deadman*. This wood is about 4 inches in diameter and is buried 18 inches deep, 5 or 8 feet from the house and parallel to it (figure 19). Doubled No. 8 galvanized wire is run from the top of the post, above the wire for the cloth, to the deadman. This is called a *guy wire*. It is tightened by twisting the two wires together with a wooden turnbuckle.

The posts are wrapped with newspaper to prevent the cloth from chafing (figure 20).

A 1-by-6-inch or 1-by-8-inch baseboard is set on edge and nailed to the posts at the ground level. This is banked with soil to prevent insects from crawling under.

Number 8 or 10 galvanized wire is run from post to post, around the house, 5 feet 11 inches above the baseboard. It should be stretched tightly and fastened securely to the posts. Wire also is run across and lengthwise of the house between posts to hold the cloth from sagging (figure 21).

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[5]Names of companies supplying cloth may be obtained by writing to the Department of Floriculture and Ornamental Horticulture, New York State College of Agriculture, Ithaca, New York.

The cloth for the top of the house is run out over the wires, spread, and fastened at the edges of the house with 6-penny nails or clothespins.

It is advisable to start fastening on the windward side, near one end. From 4 to 6 inches of cloth is left at the end for wrapping around the wire. The side cloth is then run around the house and fastened to the top wire.

Small bag needles are threaded with 12-ply cotton thread, cut in pieces about 9 feet long. Starting at the end, the side and top cloth is sewed to the wire at the same time (figure 23). The lock stitch is used, with the stitches placed at intervals of 3 or 4 inches.

Two men work together, one wrapping the edge of the cloth to the wire while the other sews. If the house has been properly constructed the sewing will be through the selvage edge of the cloth, which adds greater strength to it than if sewed farther in on the cloth.

FIGURE 20. NEWSPAPER WRAPPING PREVENTS CHAFING

The cloth is not sewed to the cross wires. This allows more play for the cloth and prevents tearing. Some growers use a board along the end of the top of the house and fasten number 18 wire to this every 3 feet, running it lengthwise of the house for added support to prevent sagging.

Formerly the cloth was fastened to the baseboard with lath. This resulted in some rotting. At present cloth companies fit the cloth with brass gommlets, through which nails are inserted, or with metal clips which fasten to the bottom of the cloth and are nailed to the baseboard.

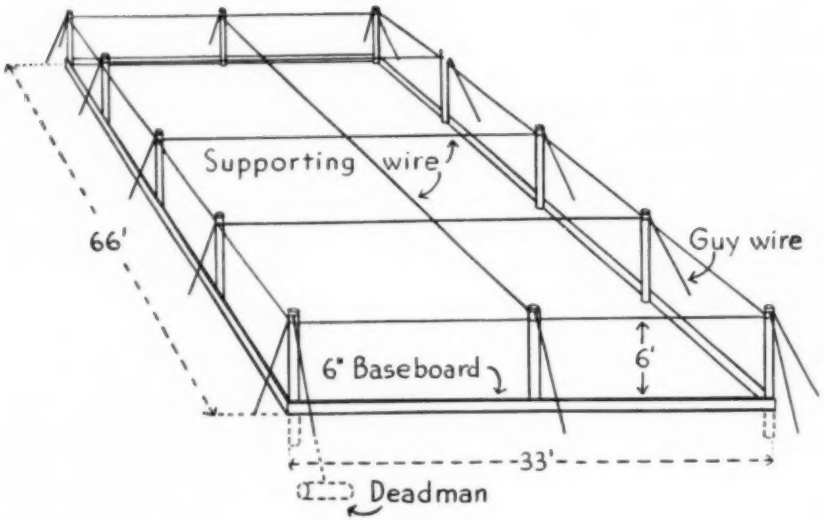

FIGURE 21. FRAMEWORK FOR A 60-BY-33-FOOT CLOTH HOUSE

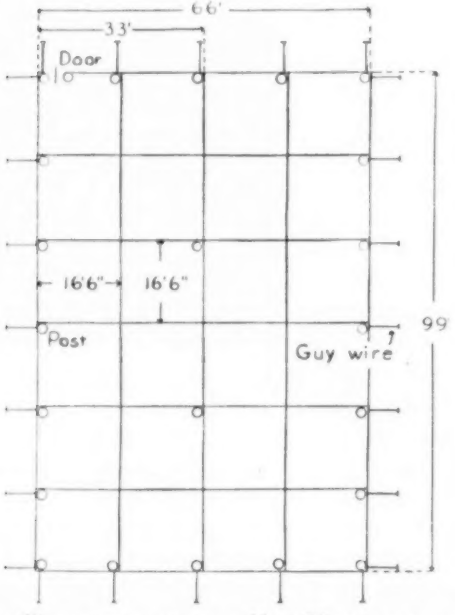

FIGURE 22. GROUND PLAN FOR A 66-BY-99-FOOT CLOTH HOUSE

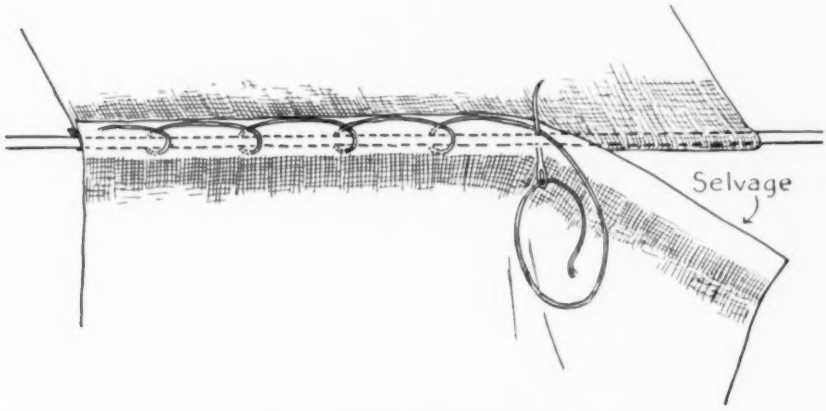

FIGURE 23. THE LOCK STITCH

The door must be fitted to prevent the entrance of insects. It should be of wire screen or cloth. A screen-door spring, to make certain the door is kept closed, is desirable.

The house should be erected before the plants are placed in it. Much of the benefit of planting under cloth results from the protection from sunlight given at transplanting time. Insects also are kept out if the cloth is present at planting time.

Materials for Cloth House 66 by 33 Feet, with Posts 16½ Feet Apart

13 posts 10′ or 12′
16 pieces of 2″ × 4″ × 2′ for anchor posts (deadmen)
200 linear feet of 1′ × 6″ boards for base
40 pounds of number 10, or 55 pounds of number 8, galvanized steel wire
3 pounds of fence staples
1 pound of 11-gauge galvanized roofing nails
2 pounds of number 8 nails
256 square yards of cloth for top, 400″ wide
140 square yards of cloth for side, 72″ wide
12-ply twine*
2, 4-inch bag needles
Clothes pins or casing nails to temporarily hold cloth in place while sewing.

*Twine and needles are supplied with the cloth by some companies.

Lath House

Plants that require shade during the summer or those not quite hardy in winter are often grown in lath houses (figure 24). They are more permanent than cloth houses and are desirable for storing palms during the summer, and for growing azaleas and other plants. Usually they are made with a flat roof. If standard 4-foot lath are used, the house is 6 feet tall and is in sections with upright posts at 12-feet intervals to support the top.

Lath sashes are often used during the summer in place of glass on cold-frames, hotbeds, and the like.

FIGURE 24. A LATH HOUSE

A publication of the
New York State College of Agriculture,
a unit of the State University of New York,
at Cornell University

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